State of California
The Resources Agency
DEPARTMENT OF FISH AND GAME

STANDING STOCKS OF FISHES IN SECTIONS OF INDIAN CREEK, PLUMAS COUNTY, 1986

Bay-Delta Project
Contract Services Section

By

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INTRODUCTION

In 1976, the Department of Water Resources (DWR), Northern District, initiated an instream flow program. The purpose of this program is to identify streams that would benefit from flow enhancement, assess instream values and identify trade-offs required to enhance these streams. Indian Creek below Antelope Reservoir (Figure 1) was selected as one of the streams to study under this program. Initial flow studies by DWR indicated that flow augmentation could double trout habitat in the first 16 km of Indian Creek below the dam and increase habitat by 25% in lower reaches (Hinton, MS). As a result of this study, DWR and the Department of Fish and Game (DFG) decided on a trial reoperation of Antelope Reservoir in 1977 by increasing flow releases from less than 0.1 cubic metres per second (m^3/s) to 0.6 m^3/s year-round on normal and wet years (Hinton and Haines, 1981). These flow changes were constrained by a requirement that recreation at Antelope Reservoir not be impaired.

The role of the DFG Contract Services Section in this study is to monitor fish populations in selected sections of Indian Creek. Previous studies of this stream have described fish populations and growth statistics (Brown, 1978; Brown and Haines, 1979; Haines and Brown, 1980; Villa and Brown, 1981; Villa, 1982). This report describes the sections of the creek sampled, fish species caught, and fish biomass at each station during fall 1986.

METHODS

Standing stocks of fishes were estimated at six stations in Indian Creek (Figure 1). Each station contained riffles and pools. Stations were selected to duplicate or to be near stations that had been sampled in previous studies (Appendix I). All stations could not be exactly duplicated because changes in physical habitat had occurred. Changes were due to floods and mining. Markers were placed in trees along the stream to permanently establish station boundaries for future sampling. Each station had similar physical characteristics as the stream reach in which it was located. Stations varied in length from 27 to 74 m. The length, average width, average depth, and ratio of pools to riffles of each station were measured with a cloth tape. Fish were captured with a battery-powered backpack electroshocker (Smith-Root, Type VII) in stream sections blocked by seines. Fish were removed from the net-enclosed section on each pass. Standing stock estimates were developed using the two-count method of Seber and LeCren (1967) or the multiple-pass method of Leslie and Davis (1939) with limits of confidence computed using a formula proposed by DeLury (1951).

The weights for rainbow trout (Salmo gardneri) and brown trout (Salmo trutta) were determined by displacement. Weights were not measured for Sacramento suckers (Catostomus occidentalis) or Sacramento squawfish (Ptychocheilus grandis). Fork length of most trout was measured to the nearest millimetre. Some trout escaped. Fish other than trout were not measured.

Trout scales were dry-mounted between microscope slides and their images were projected on a NCR microfiche reader at a magnification of 42X. Scale measurements for the calculation of growth were recorded to the nearest millimetre along the anterior radius of the anterior-posterior axis of the scale.

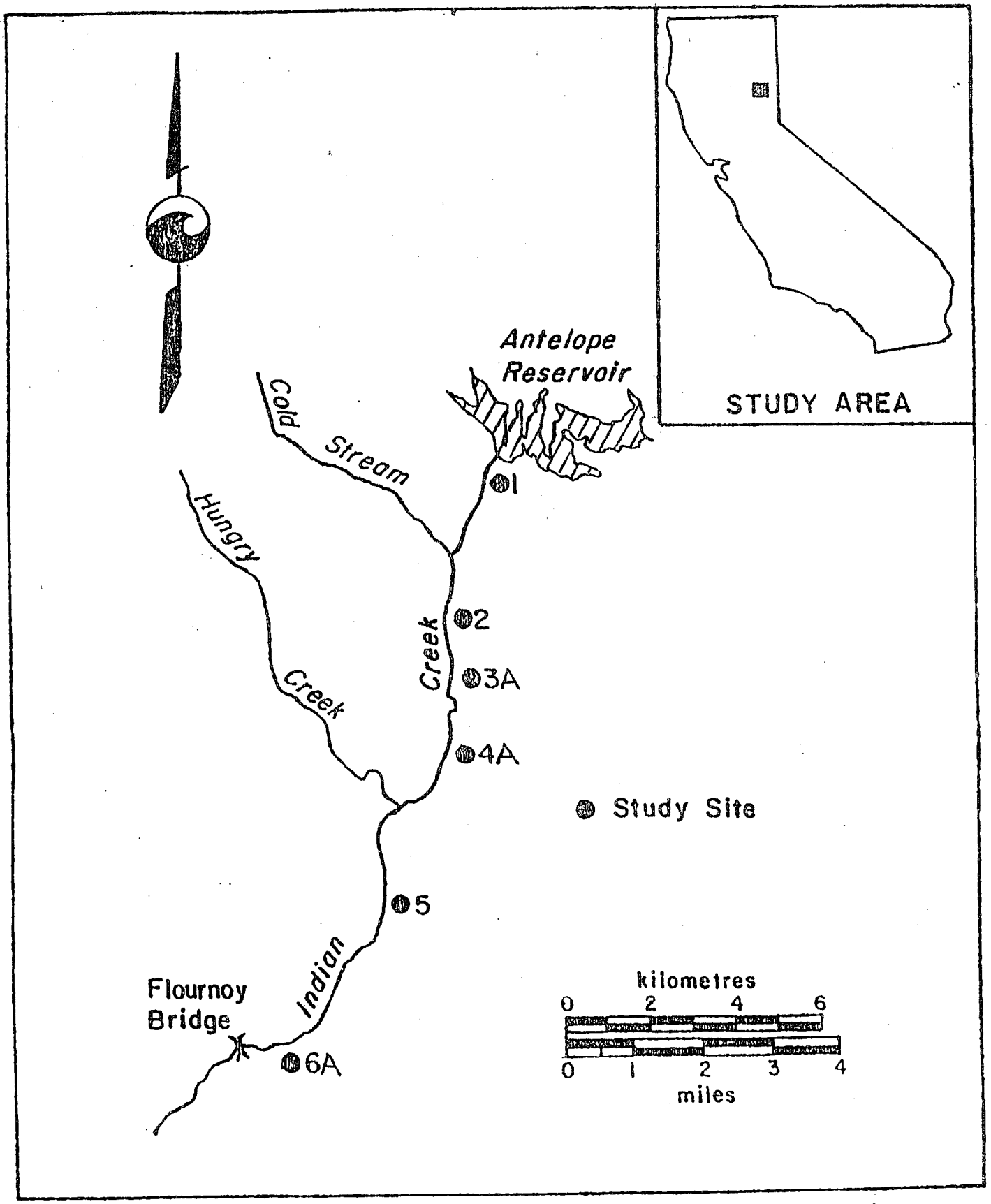

Figure 1 - Stations sampled to determine biomass of fishes in Indian Creek, Plumas County, September 1986

Predictive regressions were used to describe the body-scale and length-weight relationships (Ricker, 1975). Estimation of true mean growth rate (G) was calculated using the methods of Ricker (op. cit.).

RESULTS

Distribution

Brown trout, rainbow trout, Sacramento sucker, and Sacramento squawfish were caught in Indian Creek. Brown trout were caught at every station. Rainbow trout were caught at all stations except station 3A. Sacramento suckers and Sacramento squawfish were caught only at the lowest section of the sampling area (Table 1).

TABLE 1. Distribution of Fishes in Sections of Indian Creek, Plumas County, 1986

	Station Number					
	1	2	3A	4A	5	6A
Distance below Antelope Dam (km)	0.6	4.7	5.9	7.3	12.0	17.0
Brown trout	X	X	X	X	X	X
Rainbow trout	X	X		X	X	X
Sacramento sucker						X
Sacramento squawfish						X

Standing Crop

Rainbow trout were the most common game fish caught (77). Biomass averaged 1.1 g/m^2 at five stations (Table 2). Brown trout numbered 60 and averaged 1.5 g/m^2 in five stations (Table 3). Brown trout large enough for fishermen to catch and keep (127 mm FL) averaged 2.5 g/m^2, and rainbow trout large enough to catch and keep (127 mm FL) averaged 1.0 g/m^2.

Sacramento sucker was the most common non-salmonid fish caught. Biomass averages were not calculated for Sacramento sucker and Sacramento squawfish, since weights were not recorded for nongame fishes (Table 4).

TABLE 2. Estimates of Rainbow Trout Standing Crop in Indian Creek, Plumas County, 1986

Distance Below Antelope Dam (km)	Population Estimate	95% Confidence Interval	Biomass g/m	Estimate of Catchable Trout (127 mm FL)	Biomass of Catchable Trout g/m
0.6	57	51-63	1.3	9	1.1
4.7	1	1-1	0.4	1	0.4
7.3	1	1-1	0.2	1	0.2
12.0	15	11-19	0.3	5	0.2
17.0	13	7-19	3.4	7	3.2
			x = 1.1		x = 1.0

TABLE 3. Estimate of Brown Trout Standing Crop in Indian Creek, Plumas County, 1986

Distance Below Antelope Dam (km)	Population Estimate	95% Confidence Interval	Biomass g/m	Estimate of Catchable Trout (127 mm FL)	Biomass of Catchable Trout g/m
0.6	5	3-7	1.0	5	1.2
4.7	12	11-13	4.5	12	4.5
5.9	14	13-15	2.0	13	2.0
7.3	22	18-26	5.0	22	5.2
12.0	14	10-18	1.1	11	0.9
17.0	2	2-2	1.4	2	1.4
			x = 2.5		x = 2.5

TABLE 4. Estimates of Population of Nongame Fishes in Indian Creek, Plumas County, 1986

Distance Below Antelope Dam (km)	Species	Population Estimate	95% Confidence Interval
17.0	Sacramento squawfish	7	7-8
17.0	Sacramento sucker	54	54-118

Age and Growth

The equation L = 27.2 + 3.7 S describes the relationship between the fork length (L) and enlarged scale radius (S) of 211 brown trout. The coefficient of correlation (r^2) is 0.81. The equation was L = 59.2 + 3.5 S for 57 rainbow trout. The value for r^2 is 0.69.

Growth as measured for the population and for the mean of individual growth rates was faster for age 1+ brown trout than for age 2+ fish (Table 5). Growth as measured for the population and for the mean of individual growth rates was faster for age 2+ rainbow trout than for age 1+ fish (Table 6).

TABLE 5. Growth Rates for Brown Trout Caught in Indian Creek, 1986[1/]

	Population Growth			Mean Individual Growth		
Age Interval	Length Interval mm	Difference of Natural Logarithms	Instantaneous Growth Rate Gx	Length Interval mm	Difference of Natural Logarithms	Instantaneous Growth Rate Gx
1-2	100-196	0.673	1.183	101-196	0.663	1.803
2-3	196-282	0.364	0.808	188-282	0.405	0.900

TABLE 6. Growth Rates for Rainbow Trout Caught in Indian Creek, 1986[1/]

	Population Growth			Mean Individual Growth		
Age Interval	Length Interval mm	Difference of Natural Logarithms	Instantaneous Growth Rate Gx	Length Interval mm	Difference of Natural Logarithms	Instantaneous Growth Rate Gx
1-2	130-198	0.421	0.445	134-198	0.390	0.412
2-3	198-402	0.708	1.576	225-402	0.580	1.291

1/ Only data which contained lengths and weights were used in calculating growth rates.

One 5+ brown trout was caught. This fish measured 560 mm in length, while 4+ fish averaged 427 mm, 3+ averaged 316 mm, 2+ fish averaged 237 mm, and 1+ fish averaged 181 mm (Table 7).

TABLE 7. Calculated Fork Length in Millimetres of Brown Trout from Indian Creek, Plumas County, Taken in September 1986

Age	No. of Fish	Mean Fork Length at Capture	Calculated Lengths at Successive Annuli 1	2	3	4	5
1	50	215	100	-	-	-	-
2	134	295	101	196	-	-	-
3	22	366	99	188	282	-	-
4	4	550	100	196	303	404	-
5	1	560	82	198	310	394	473
Number of back-calculations			211	161	27	5	1
Weighted means (mm)			100	195	286	402	473
Increments (mm)			100	95	91	116	71

One 3+ rainbow trout was caught. This fish measured 350 mm in length, while 2+ fish averaged 240 mm, 1+ fish averaged 182 mm, and 0+ fish averaged 84 mm (Table 8).

TABLE 8. Calculated Fork Length in Millimetres of Rainbow Trout from Indian Creek, Plumas County, Taken from April-September 1986[2/]

Age	No. of Fish	Length at Capture	Calculated Lengths at Successive Annuli 1	2	3
1	46	225	130	-	-
2	10	265	118	198	-
3	1	350	188	315	402
Number of back-calculations			57	11	1
Weighted means (mm)			129	209	402
Increments (mm)			129	80	193

2/ All fish were used in making the back calculations, including those collected without weights.

Age group 0+ brown trout represented 0% of the catch, while 1+ fish made up 65%, and 2+ fish comprised 35% (Figure 2). In contrast, age 0+ rainbow trout comprised 40% of the catch, while age 1+ and 2+ fish made up 54% and 6%, respectively. All rainbow trout caught are represented in Figure 3.

Length and Weight

The relationship between length (L) and weight (W) of brown trout is:

$Log_{10}W = -4.10 + 2.64\ Log_{10}L$

$r = 0.97$

$r^2 = 0.94$

$N = 60$ (Figure 4) (Appendix 2)

The same relationship for rainbow trout is:

$Log_{10}W = -4.83 + 2.95\ Log_{10}L$

$r = 0.99$

$r^2 = 0.98$

$N = 35$ (Figure 5) (Appendix 3)

Only known lengths and weights of fish data were used; extrapolations were not made to include fish data without known weights.

Coefficient of Condition

We calculated the coefficient of condition and 95% confidence limits for 60 brown trout and 35 rainbow trout (Table 9).

There is no significant difference between the coefficient of condition for any age group of rainbow trout or brown trout we tested ("t" test, 0.05 level).

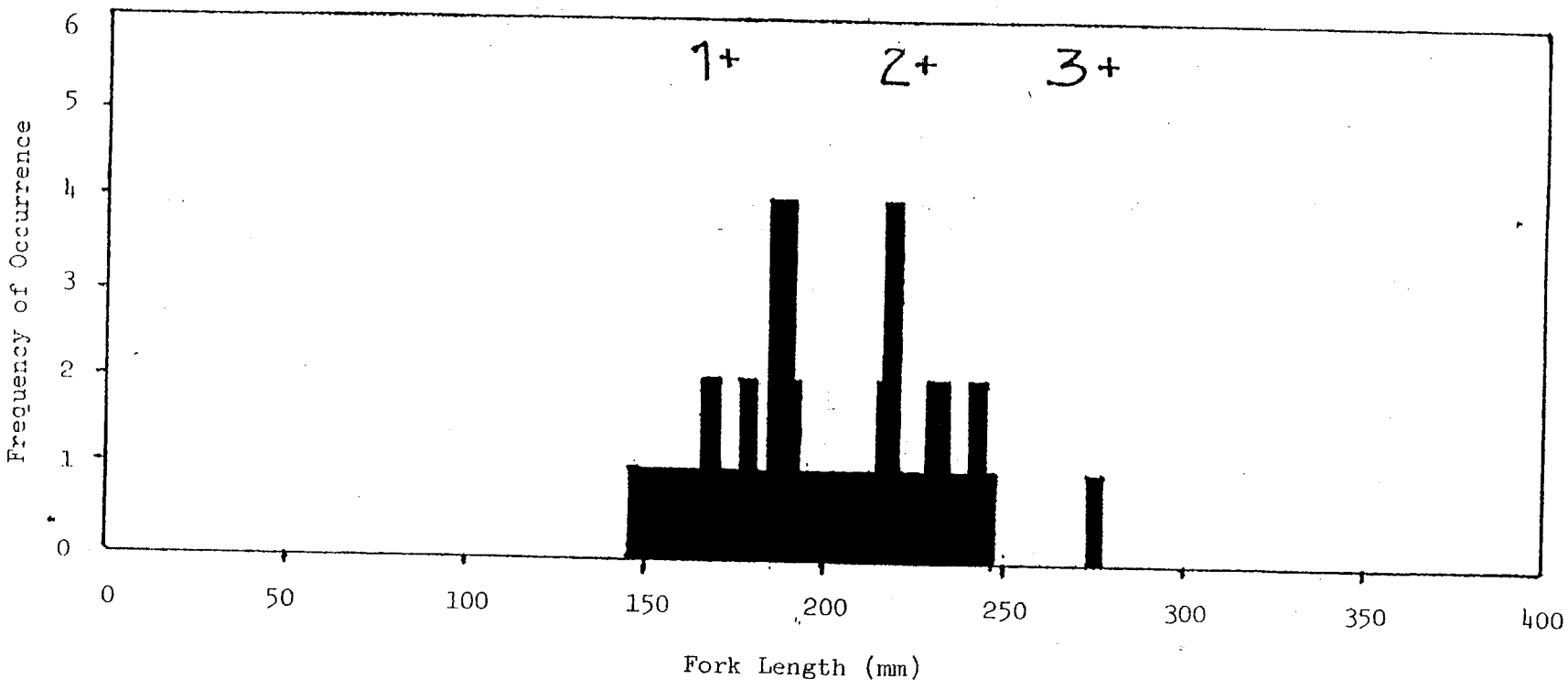

FIGURE 2 Length, frequency of occurrence and age of brown trout caught in sections of Indian Creek, Plumas County, 1986.

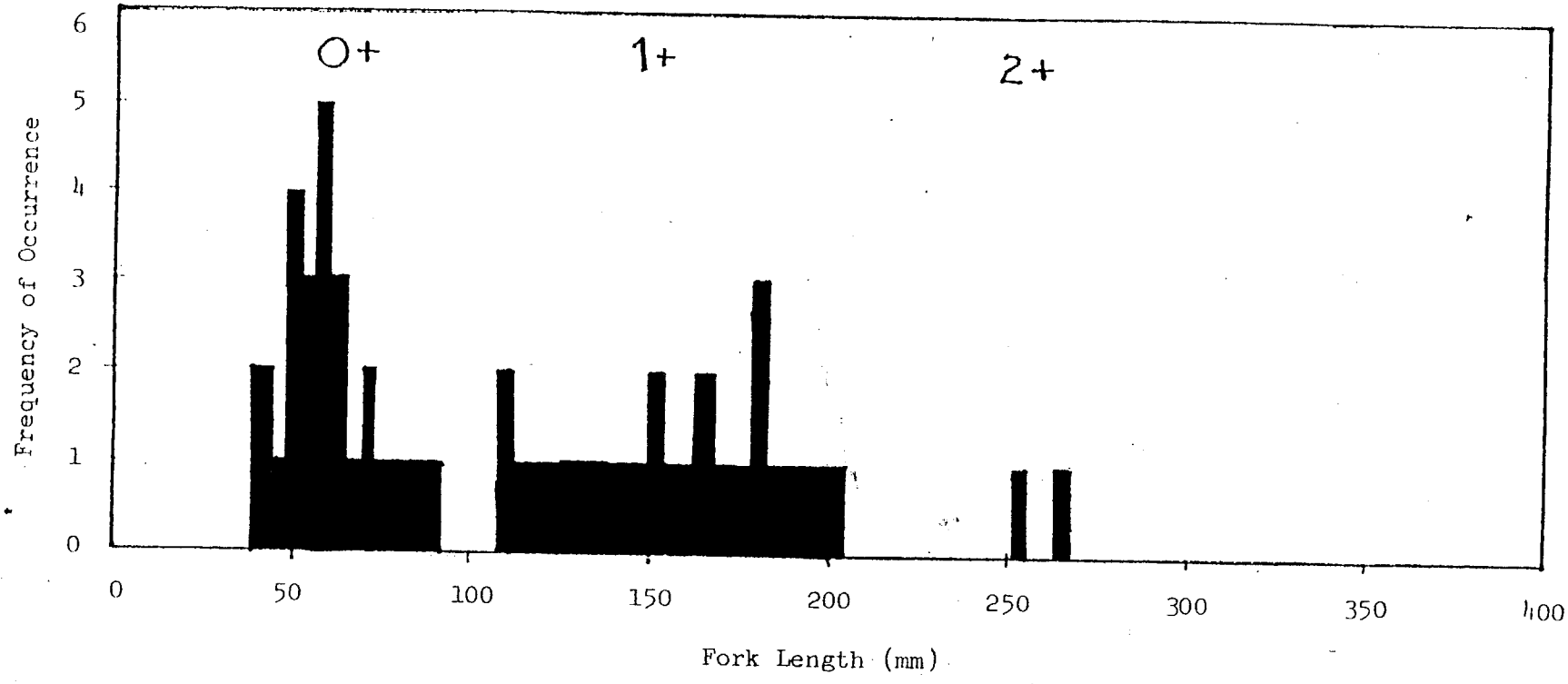

FIGURE 3 Length, frequency of occurrence and age of rainbow trout caught in sections of Indian Creek, Plumas County, 1986.

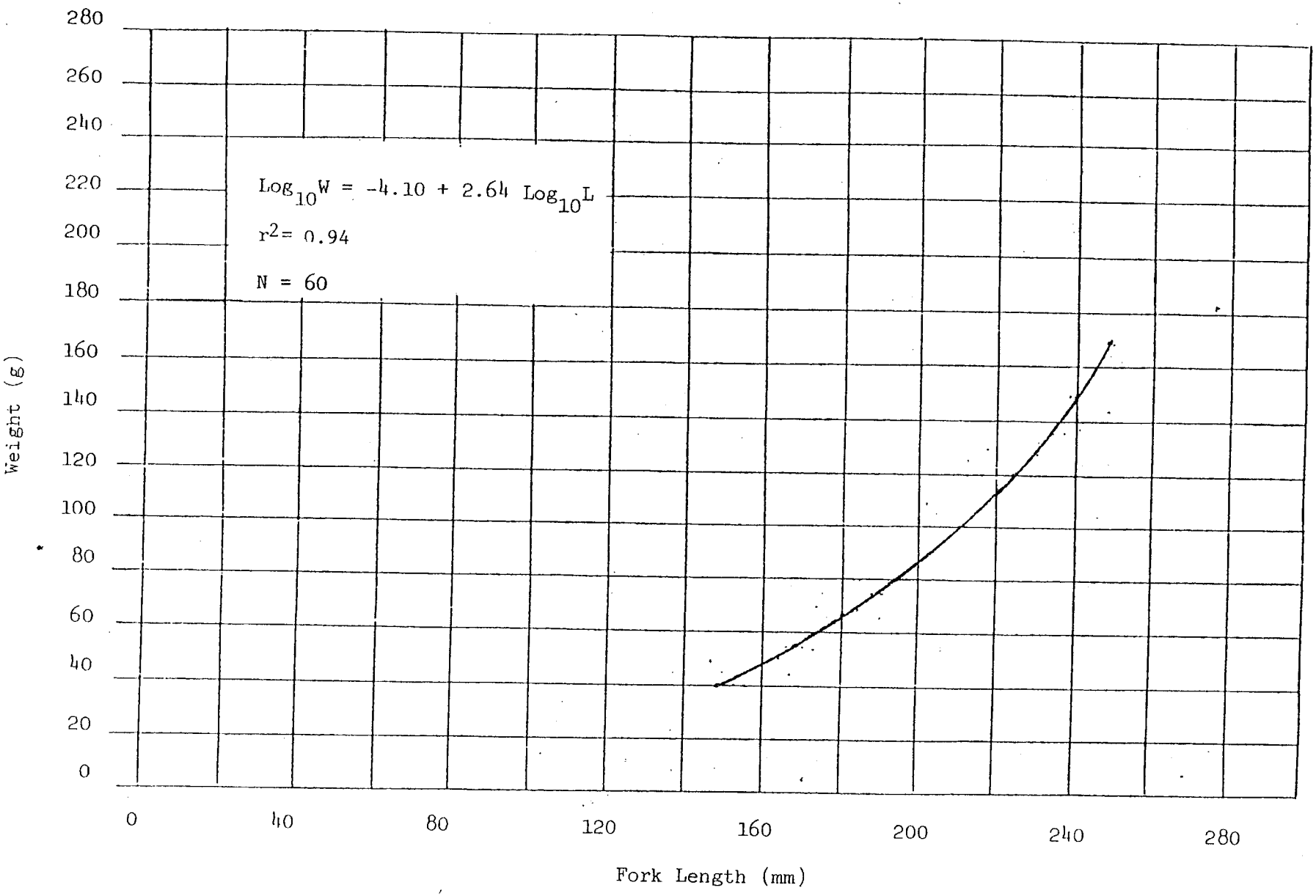

FIGURE 4 The relationship between length and weight of brown trout caught in sections of Indian Creek, Plumas County, 1986.

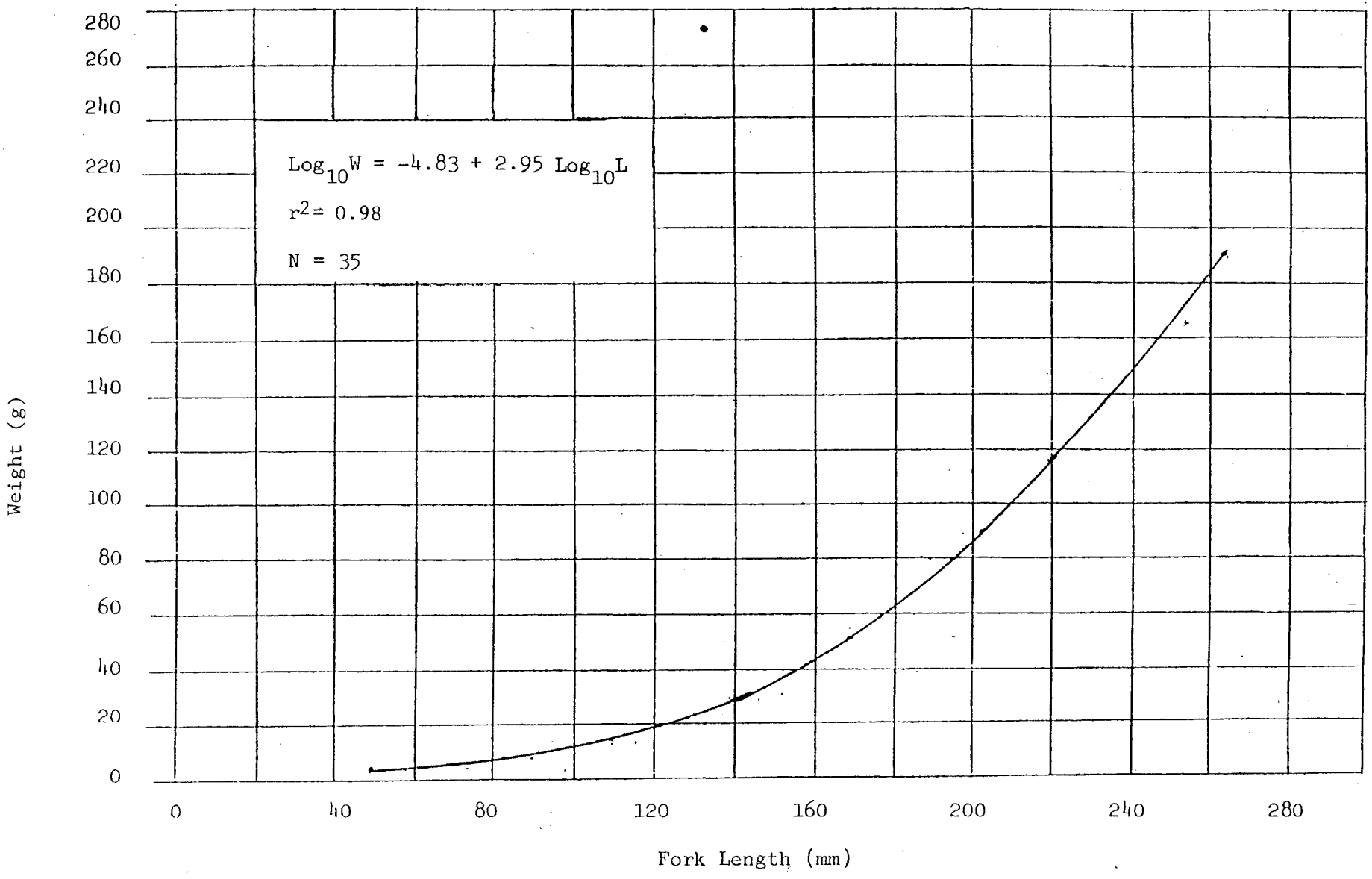

FIGURE 5 The relationship between length and weight of rainbow trout caught in sections of Indian Creek, Plumas County, 1986.

TABLE 9. Condition of Brown Trout and Rainbow Trout in Indian Creek, 1986

Age Group	Number of Fish	Coefficient of Condition	95% Confidence Interval
Brown trout			
1+	42	0.179	0.976-1.204
2+	18	0.146	0.782-1.352
Combined	60	1.142	0.880-1.404
Rainbow trout			
0+	14	1.165	1.028-1.302
1+	19	1.122	1.008-1.236
2+	2	1.066	1.021-1.111
Combined	35	1.136	1.012-1.260

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APPENDIX 1

PERMANENT FISH POPULATION STATIONS
INDIAN CREEK, PLUMAS COUNTY
SEPTEMBER 1986

APPENDIX 1

PERMANENT FISH POPULATION STATIONS
INDIAN CREEK, PLUMAS COUNTY
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Indian Creek has had two periods of very high runoff (late-May 1983 and mid-February 1986), since fish populations were last sampled in September 1982. High flows during these periods severely eroded streambanks in meadow sections of the creek, toppled many trees into the creek, deposited large quantities of sand and gravel, and rerouted the stream channel in many locations. Thus, although three of the six stations sampled in 1986 are the same locations sampled in previous years, none of the stations are truly comparable to those sampled in previous years. One of the new stations (6A) was picked because it appears to be similar to the station it replaced; the other two (3A and 4A) are quite different from the old stations but seem to represent typical habitat in those portions of the creek.

Station 1 - Located 0.6 stream km (0.4 mi) below Antelope Dam adjacent to the picnic area near the junction of Indian Creek Road and the spur road leading to the base of the dam (NE 1/4 of NE 1/4, Section 27, T27N, R12E). Although there is some erosion along the left bank, and evidence of a few inches of channel degradation, this station appears to be similar to 1978 and 1979 before beaver dams flooded the lower portion of the station. The station consists of a pool and run area (40%) between two riffles (60%). It is 70 m long and has a surface area of 542 m^2 and a volume of 117 m^3 at 0.56 m^3/s.

Station 2 - Located 4.6 km (2.9 mi) below Antelope Dam and 1.8 km (1.2 mi) below Cold Stream (SW 1/4 of SW 1/4, Section 34, T27N, R12E). The station is 27 m long, marked by a 36-cm-diameter alder (RB) and a 10-cm-diameter pine, both with metal disks now barely visible from the road. This station looks similar to previous years. It contains riffle (65%) and shallow pool (35%) areas. The station has a surface area of 253 m^2 and a volume of 90 m^3 at 0.56 m^3/s.

Station 3A - Located about 6.0 stream km (3.7 mi) below Antelope Dam and 1.4 km (0.9 mi)above Babcock Crossing (NW 1/4 of NW 1/4, Section 10, T26N, R12E). This station replaces one just downstream which has been eroded into a deep pool too lengthy to electrofish. The new station has three pools (75%) separated by short riffle areas (25%). There are several downed trees on the eroded LB. Unlike the station it replaces, this station has little shade. The new station is 64 m long and has a surface area of 470 m^2 and a volume of 110 m^3 at 0.56 m^3/s.

Station 4A - Located about 7.3 stream km (4.5 mi) below Antelope Dam and 0.2 km (0.1 mi) above Babcock Crossing (NW 1/4 of SW 1/4, Section 10, T26N, R12E). This new station is located about 0.2 km (0.1 mi) downstream from the previous station and about halfway between Babcock Crossing and a parking turnout 0.3 km (0.2 mi) upstream. The station contains two small pools (60%) separated by riffle areas (40%). Like the station it replaces, it is mostly unshaded. The station is 57 m long and has a surface area of 449 m^2 and a volume of 119 m^3 at 0.56 m^3/s.

Station 5 - Located at an unimproved campground about 12.0 km (7.4 mi) below Antelope Dam and 6.0 km (3.7 mi) above Flournoy Bridge (SW 1/4 of SW 1/4, Section 21, T26N, R12E). The station extends 74 m upstream from the lower end of a riffle area adjacent to the turnaround at the end of the paved access road (Transect 3 of the instream flow study). Metal disks remain on a small willow (LB) at the lower end of the station. The station contains a riffle and shallow run area, a large 0.8-m deep pool with undercut bank (RB), and a shallow riffle area. Riffle area is 60%, pool area 40%. The station was greatly modified this summer by gold-dredging activities of United Prospectors, Inc. Recreational miners deepened undercut banks, dug numerous pits, and left scattered piles of rubble. The station has a surface area of 770 m^2 and a volume of 253 m^3 at 0.56 m^3/s.

Station 6A - Located about 16.8 km (10.4 mi) below Antelope Dam and about 1.2 km (0.7 mi) above Flournoy Bridge (NE 1/4 of SW 1/4, Section 31, T26N, R12E). (Drive 0.3 km (0.2 mi) east of Flournoy Bridge on the Indian Creek road and take the paved spur road to the right 0.6 km (0.4 mi) to a gate in the fence on the right side of the road where the creek turns south from the road. Follow a trail along the streambank downstream about 35 m.) The lower end of the station is located at a steep rapid at the lower end of the alders where the streambed widens abruptly. The new station is located just upstream of the original station, which was greatly changed by the February 1986 flood. The station is a rocky run with several small pockets of slow water and undercut bank on RB. Riffle area totals 60% and pool area 40%. The station is 33 m long with a surface area of 214 m^2 and a volume of 58 m^3 at 0.56 m^3/s.

APPENDIX 2

LENGTH AND WEIGHT OF BROWN TROUT
CAUGHT IN INDIAN CREEK
SEPTEMBER 1986

APPENDIX 2

LENGTH AND WEIGHT OF BROWN TROUT
CAUGHT IN INDIAN CREEK, SEPTEMBER 1986

Length (mm)	Weight (g)	Length (mm)	Weight (g)
146	40	189	75, 65
148	50	190	75
149	40	192	85
150	45	197	90
151	40	200	90
152	50	201	95
154	40	203	110
155	40	205	100
161	40	208	105
165	50	210	105
166	55	211	100
167	55	217	120
168	60	218	110,110,140
169	55, 55	221	125, 110
170	60	231	135, 130
172	55	232	140, 140
174	70	239	150
177	75	241	125, 140
178	60	242	160
180	60, 75	245	170
181	70	266	110
186	75, 80, 80	273	225
187	75, 75	275	220
188	75	279	230

APPENDIX 3

LENGTH AND NUMBER OF BROWN TROUT
CAUGHT IN INDIAN CREEK
SEPTEMBER 1986

APPENDIX 3

LENGTH AND NUMBER OF BROWN TROUT
CAUGHT IN INDIAN CREEK, SEPTEMBER 1986

Length (mm)	Number	Length (mm)	Number
146	1	189	2
148	1	190	1
149	1	192	1
150	1	197	1
151	1	200	1
152	1	201	1
154	1	203	1
155	1	205	1
161	1	208	1
165	1	210	1
166	1	211	1
167	1	217	1
168	1	218	3
169	2	221	2
170	1	231	2
172	1	232	2
174	1	239	1
177	1	241	2
178	1	242	1
180	2	245	1
181	1	266	1
186	3	273	1
187	2	275	1
188	1	279	1

APPENDIX 4

LENGTH AND WEIGHT OF RAINBOW TROUT
CAUGHT IN INDIAN CREEK
SEPTEMBER 1986

APPENDIX 4

LENGTH AND WEIGHT OF RAINBOW TROUT
CAUGHT IN INDIAN CREEK, SEPTEMBER 1986

Length (mm)	Weight (g)	Length (mm)	Weight (g)
58	2	142	30
60	2.5	146	30
62	3.5	151	30, 40
64	3	160	55
67	4	167	50, 55
72	4	180	70, 75
79	6.5	185	60
82	6	187	80
84	7	190	80
93	9	192	80
110	17, 14.5	195	90
118	15	197	90
121	20	204	90
134	25	253	180
138	30	265	190
140	30		

APPENDIX 5

LENGTH AND NUMBER OF RAINBOW TROUT
CAUGHT IN INDIAN CREEK
SEPTEMBER 1986

APPENDIX 5

LENGTH AND NUMBER OF RAINBOW TROUT CAUGHT
IN INDIAN CREEK, SEPTEMBER 1986

Length (mm)	Number	Length (mm)	Number
44	2	93	1
46	1	110	2
47	1	118	1
50	4	121	1
51	3	128	1
52	3	134	1
53	2	138	1
54	1	140	1
55	3	142	1
56	1	146	1
57	5	151	2
58	3	160	1
60	4	167	2
62	2	168	1
64	3	180	3
65	1	185	1
67	1	187	1
68	1	190	1
70	1	192	1
72	2	195	1
75	1	197	1
79	1	204	1
82	1	253	1
84	1	265	1

APPENDIX 6

METRIC CONVERSION FACTORS

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METRIC CONVERSION FACTORS

Quantity	Metric Units	Divide by	English Units
Length	millimetres (mm)	25.4	inches (in)
	centimetres (cm)	2.54	inches (in)
	metres (m)	0.3048	feet (ft)
	kilometres (km)	1.6093	miles (mi)
Area	square metres (m^2)	0.0929	square feet (ft^2)
Volume	cubic metres (m^3)	0.7646	cubic yards (yd^3)
Flow	cubic metres per second (m^3/s)	0.0283	cubic feet per second (cfs)
Biomass	grams per square metre (g/m^2	8.92	pounds per acre (lb/acre)